

Chapter 1

Ornamental Horticulture: Economic Importance, Current Scenario and Future Prospects



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Abstract Ornamental horticulture comprises production of cut flowers, potted plants and cut foliage crops, which is highly competitive on account of advances in infrastructure availability, improved varieties development, postharvest handling and marketing options. With rise in production costs, floriculture production is shifting from the three most important global producers, The Netherlands, USA and Japan to some Latin American, African and Asian countries, where growing conditions are favorable and resources are cheaper. Among ornamental plant production for landscape and interiorscapes, ornamental palm production is a high demanding segment, which has high value all over the world. In this chapter, ornamental palm types, economic importance, and future prospects are described along with their basic characteristics and growing requirements.

Keywords Horticulture · Economic importance · Ornamental palms · Interiorscapes

1.1 Introduction

Floriculture consists of four major components, viz. cut flowers, potted plants (including potted flowers and potted greens), cut foliage, and bedding/garden plants. Compared to fruits and vegetables, floricultural products require higher initial investment, efficient management and a high-tech production technology. Therefore, their profitability per unit area is much higher than other agricultural commodities. According to a report, value per ha in The Netherlands has reached to \$138,000

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followed by Colombia having \$100,000 (BIOX 2005). Floricultural production ranks among top four export earning commodities, that include petroleum, coffee, and bananas (BCMAFF 2003). The Netherlands, Japan, and USA are global leaders in floriculture production with approximately \$44 billion value (Marques and Caixeta Filho 2003). Moreover, per capita consumption of floriculture products varies greatly in different countries with developed countries generally having a higher consumption, such as Switzerland €136, which ranked first in all countries, followed by Norway at €14 per capita (IFTS 2004). Presently, the Netherlands, the US and Japan are the leading floricultural producers in the world followed by Colombia, Kenya, Ecuador, Ethiopia and Zimbabwe, which are emerging floricultural economies during last two decades (Wijk 1994; Kenya Flower Council 2005).

There are more than 120 countries in the world which are actively involved in floriculture production. Japan, leading with a production value worth \$3.7 billion, whereas The Netherlands, with \$3.6 billion and the USA, with \$3.3 billion accounted for more than half of the world total (Papademetriou and Dadlani 1998). In 2004, the total production value was around \$75 billion, of which The Netherlands had a €3.6 billion share (FCH 2004), USA had \$5.18 billion (USDA 2005), while Japan had \$3.47 billion (MAFFJ 2002–2006). In terms of areas under floriculture crops, China and India are leading with more than 75,000 ha in China and 65,000 ha in India (Yang et al. 1998; CMA 2005). The proportion of different floriculture products varies greatly among countries (IFTS 2004; USDA 2004; 2005). The main floriculture products are cut flowers (45.3% in Germany, 48.5% in The Netherlands, 15.7% in USA, 31.6% in China and 99.3% in Colombia), potted flowers (34.8% in The Netherlands and 39.1% in China), and bedding and garden plants (51.8% in USA) (MAFFJ 2002–2006). Among these, cut flowers are the leading product in world floriculture trade. In 2001, fresh cut flowers shared 50.5% of the world trade value of floriculture (Laws 2004), the top four crops, in decreasing order, being roses, chrysanthemums, carnations and lilies. Production of huge amounts of high quality flowers all year around, with lower labor and other production costs, induced some floriculture production shifts towards Southern Hemisphere countries. The Global production of floriculture products will likely continue to expand, especially in developing countries in Africa, Latin America and Asia, whose productivity is expected to increase further. Traditional large producing countries such as The Netherlands, Japan and the USA continue to lead global production, increasing productivity per worker and unit area. Total area under production will remain stable or drop slightly in these three countries. Production of highly labor-intensive cut flowers will shift in areas with lower labor and other production costs.

During last two decades, floriculture production has shifted to many developing countries having favorable climatic conditions and fertile soils, with cheap labor and friendly export/import policies. These countries include Kenya, Colombia, Ecuador, Ethiopia, Zimbabwe, Malaysia etc., whose exports are rising day by day to European countries. Around the globe, there are three significant floriculture consumption regions, viz. Europe (66.7%), USA (19.3%) and Japan (10.7%). From a country perspective, USA is the biggest consumer at \$6.99 billion, sharing 19.3% of the world total value. Germany is second largest (18.8%), followed by Japan

(10.7%), France (8.5%), United Kingdom (8.5%), Italy (6.8%), The Netherlands (4.1%), Spain (4.1%), Switzerland (2.6%), and Poland (2.6%). These ten countries account for 85% of the world total floriculture consumption. On a per capita basis, generally European countries have a higher floriculture consumption with Switzerland (\$136), Norway (\$114), The Netherlands (\$93), Denmark (\$83), Germany (\$83), Austria (\$78), Sweden (\$77), and Belgium (\$69) having higher per capita consumption. Outside Europe, Japan (\$31) and the USA (\$51) have relatively lower consumption per capita (Xia et al. 2006). Cut flower use is expected to still rise in coming years, particularly in Asian countries, where floriculture markets will experience increasingly global competition. A number of traditional markets are showing signs of saturation, while new countries are trying to get their place on the market. At the same time, with increased living standards, new markets will develop in some regions of the world such as Eastern Europe and Asia.

Floriculture, now a visible and growing section of Horticulture, encompasses production, propagation and marketing of ornamentally important trees, shrubs, palms, indoor plants as well as flowers that address the demand of cut flowers and potted plants in market. As the greenhouse technology developed, a positive competition in three big centers of floriculture market (Europe-Africa, America and Asia-Pacific) increased globally, especially in three big producers as well as consumers of floriculture items (The Netherlands, Japan and America). World floriculture trade has been exceeded up to 50 billion US \$ while increasing daily. The Netherlands is the biggest exporter as well as importer of floriculture products, due to their distinctive way of trade. After Netherlands, Kenya, Ethiopia and Colombia are next biggest exporters (Ogawa 2004).

Pakistan is a country whose GDP depends up to 21% on agriculture. However, floriculture is a developing industry in the country but still occupies only 0.5% of arable land. Floriculture includes a vast range of commercially grown crops in all climatic regions of the country, whereas agronomic crops such as wheat, rice, maize and cereals are limited to specific regions of country. Floriculture in Pakistan is still limited to developed cities such as Karachi, Lahore, Islamabad, Peshawar and Faisalabad, while Pattoki (Kasur district) is biggest producing region as well as national market hub for floricultural crops. In Pakistan most of farmers are small land owners, they grow agronomic crops and depend on yields. Conventional crops are economical for larger areas but a solution for small land owners may be represented by floriculture.

On the other hand, floriculture products generate high cash value as well as aesthetic food for soul. Inexpensive labor, favorable climatic conditions and easiest availability of land are key benefits for local producers. Most common constraints to producers include lack of irrigation sources, expensive hybrid seeds and corms, lack of knowledge about fertilizers, high post-harvest losses, lack of cold store facilities, no greenhouse technology, low quality of products and lack of knowledge about packaging. Unfortunately, Pakistani farmers are not producing export quality products due to the above mentioned constraints and lack of cooperation with research and business officials. Moreover, producers are not aware about export standards of world floriculture markets. Pakistan has opportunities in nearest

Chinese, Japanese, Gulf and other Asian markets, but due to continuous negligence towards floriculture, national products have negligible shares in these markets. Pakistan needs to create awareness among farmers about standards of export quality products, providing greenhouse technology, managing continuous flights, and adopting postharvest treatments and packaging, according to the world trade demand. Most of evergreen plants also require less water and fertilizer. In floriculture products, demand of cut flowers is continuously emerging and contributes a big share in Pakistan floriculture market. The requirement of evergreen plants was low until the development of housing societies while nowadays a huge number of dracaenas, dieffenbachias, colorful shrubs, exotic trees and most graceful species of ornamental palms are in the demand of every developing and developed housing scheme. Among green plants, palms have their own aesthetic, historic and economic value.

1.2 Trends and Prospects

1.2.1 New Style and High Quality

In order to fulfil the trends set by the market for fresh cut flowers, bedding plants, ornamental palms, and potted flowering plants, and to compete with low-cost production and labor countries, production systems often have to be optimized, especially in large greenhouse areas in localities around the world where climate is less than optimal. Computer systems that monitor and regulate the growth environment, movable tables for enhancing production area, supplemental lighting and mechanization (for reduced labor costs), and re-use of irrigation water are all means of achieving these production goals.

1.2.2 Transition of the Producing and Consuming Center

Traditionally wholesalers play several roles (product sourcing, brokering and handling, providing product information, credit source, identifying emerging market trends, tracking of difficult-to-find material) for retail florist customers, and have served as middle-men for a long time, providing a bulk source (local or imported) from which redistribution occurs in smaller lots to retailers. These will continue to play a major part of global cut flower markets. However, distribution centers and grower-direct-auctions are becoming increasingly popular due to greater demands to reduce costs, cuts of the middle-men and speed up purchases in a more efficient way, allowing thus for a superior quality product (longer vase life). High-tech driven markets (USA, EU, Japan, S. Korea and increasingly China) are starting to move towards online grower auctions. This tends to cut the wholesale agent and the

importer out of the picture, altogether. Retailers are also getting smarter, avoiding middle steps, and increasing purchases/sales by both traditional retailers (including large floral chains), street and special locality vendors such as supermarkets, stores, warehouses and internet sites. Retailers can be broadly categorized into three sectors: (a) specialty i.e. florist shops, garden centers, mail catalogues, craft/art specialty, toll-free numbers, farmer's markets, street vendors (accounting for 59.5% of the cut-flower market), (b) mass merchandisers i.e. supermarkets, discount chain stores, warehouse clubs, convenience stores (accounting for 36% of the cut-flower market), (c) others (4.5% of market) (van den Broek et al. 2003). This balance is definitely going to change, with a greater tendency towards (b), but this depends strongly on the national consumer market.

1.2.3 Use of the New Technologies and Advanced Facilities

A greater understanding of the physiological, genetic and ecological mechanisms underlying plant growth, flower initiation and development, and subsequent post-harvest conditions will lead to the launch of much more superior quality products onto the market, which is increasingly demanding, and reliant on novel ideas for its growth and expansion. At the same time, mass production units (either *in vitro* systems or bioreactors for mass production of micropropagules) will be essential to satisfy growing demands, which might otherwise, through conventional propagation practices, could not be fulfilled. Moreover, a greater ease, consistency and reliability of genetic transformation methods will allow the introduction of novel characters such as new colors, manipulated growth patterns and development, and also strengthen plants' responses to environmental (biotic and abiotic) stresses. There is no single factor that determines the efficiency of a production site or unit, and several aspects must be considered simultaneously: sufficient working capital, availability of suitable plant material, green or shade housing, location, ease of cultivation, well drained or suitable soil, species selection, flowering period, planting density, irrigation design, drainage, shelter or windbreaks, insects, diseases, climate, supply of labor, access to the market, weed control, spray equipment, mechanical equipment, cool room storage, and packaging facilities.

1.2.4 New Marketing System

Successful marketing and profitable exports depend on different factors such as: understanding and meeting market and customers' demands; understanding specific cultural and social customs, fashion and trends affecting buying patterns, quality of the product on arrival, product presentation and promotion. Successful marketing goes hand-in-hand with assured supply, quality product, packaging, cool chain transport and cool storage facilities, pre- and post-harvest treatments and

IPM. Marketers must be aware of color preference, stem length, bunch weights, bunching, sleeving, box size, product description sales as a consignment or as a fixed price basis. Moreover, knowledge of the export logistics (freight forwarder services, domestic transport, direct flights, customs clearance system, export documentation, packaging, pressure cooling, cool storage, distance from international airport, fumigation services), and legislative requirements (permits and authorities, quarantine, inspection, and phytosanitary certification for specified markets, import permits, duties, tariffs and customs requirements, and plant quarantine clearances of arrival in some export markets) will all ensure a sound marketing strategy.

1.3 Ornamental Palms

After cut flowers, second major segment of floriculture industry is the production of live potted plants, which accounts for around 43% of total trade. Among these, there are ornamental trees and shrubs, climbers, bedding and house plants. In this chapter, we will focus on ornamental palms. Symbolically, palm trees depicted victory, peace and productivity in many cultures in the past, while nowadays the palm is considered as a symbol of tropics and tourism.

Palms (Arecales), members of family Palmae (Arecaceae), are quite popular ornamentals in tropics and subtropics. They are placed in six subfamilies with approximately 4000 species and more than 200 genera. Palm trees have great diversity in morphology and ecology, and are commonly found in tropical, subtropical and Mediterranean climatic regions. These also have high economic value being source of food and oil, fiber, wine and other beverages, active compounds, rattan—used in furniture production—and thatch—used as roofing material—, tannins, and lumber. Moreover, palms are integral part of modern landscapes, interiorscapes, and are grown in many national and international tropical gardens, such as The Palm House at the Royal Botanical Gardens, Kew Gardens (England). In USA, primarily in California, Florida and Hawaii, palms are produced for the ornamental industry as potted, greenhouse-grown plants for interior use, or container- and field-grown plants for landscape use. While in other parts of the world, they are grown in fields for food, oil and other commercial uses.

Generally, palms are naturally distributed in tropical regions, but now the majority of them has been transported to new locations, different from their native habitats. For example, *Phoenix dactylifera*, commonly grown for its edible dates, probably originated in the Persian Gulf, but now it is commonly found throughout subtropical Florida, employed as landscape centerpieces. However, new cultivars of ornamental palms have not been bred for new environments but are transported to new locations in which they often fail to survive. This movement of palms to new environments poses great challenges to ornamental palm growers. Palms are basically monocots and their anatomical structure has important implications for their health. Each stem of a palm has a single apical meristem (bud or heart). Once the meristem is damaged—due to any pathogen, nutritional deficiency, herbicide,

mechanical or environmental factors—the plant may die. This vulnerability is particularly known in single-stem palms. Since palm stems have no vascular cambium, they are essentially devoid of secondary growth. Therefore, palms cannot repair injuries to their stems, and diligent effort must be made to prevent lesions that provide opportunities for insect and/or pathogen invasions of the trunk.

Palms are integral part of the green vegetation in many developed countries. There are almost 4000 species of palms in the world, most of which are native to warm tropical regions. However, there are a number of species native to subtropical and lower hilly areas e.g., the Chinese windmill palm (*Trachycarpus fortunei*) which is outstandingly cold-resistant and hardy. Nowadays, species of palms are available for all landscape attributes such as indoor, outdoor, potted, green belts, group plantation and corner plantation as well.

People from old age era were directly dependent on many palm trees for several important products, such as natural waxes, oils, kernels, wood, fibers, leaves and fruits etc. Nowadays, there are few economically important species, for commercial purposes. History of palm trees is as old as man itself. Although controversial, it is thought that palms were first cultivated by Mesopotamians and other Middle East civilizations around 5000 years ago. History also guides us about useful benefits and distinctive traits of palms, i.e. the date palm (*Phoenix dactylifera*), that produces high yields of energy rich fruit, the coconut palm (*Cocos nucifera*) that produces delicious fruit coconuts (while its outer covering is used as organic substrate for raising of plant seedlings), the traveler's palm (*Ravenala madagascariensis*), which is a false palm that stores water in its branches during rain that later is useful for water supply, the rattan (climbing palms) that were broadly used to make furniture chairs and handicrafts, and many others. Many palm species bear edible fruit that remained as a survival food during famines, i.e. the Southern Paitue, or the California *Washingtonia filifera* that provides fruit to feed people in starvation.

As a testimony of the historical value of palms, the word “dates” is cited 26 times in the Holy Quran.

Does any of you wish that he should have a garden with date-palms and vines and streams flowing underneath, and all kinds of fruit, while he is stricken with old age, and his children are not strong (enough to look after themselves)—that it should be caught in a whirlwind, with fire therein, and be burnt up? Thus doth Allah make clear to you (His) Signs; that ye may consider. (**Surah Al-Baqara, 266**)

Dates were also mentioned 30 times in the Bible. Palms remain as an important part of every civilization in old and middle ages, and even nowadays for many religion such as Islam, Christianity etc.

1.4 Biology of Palms

Palms are flowering angiosperms, and appeared almost 80 million years ago. Being monocots they have only a single cotyledon produced by each seed after germination. This character of palms relates very closely to bamboos and grass plants. Palms

are now growing all around the world. Even if they attain the size of trees, in relation with their growth and basic structure, palms are more relevant to other monocots such as corn, grasses, bamboos and rice etc. rather than tropical trees such as maple, oak and others (Broschat et al. 2014). In monocots there are very rare species which attain the size of a palm, i.e. a date palm that may reach up to 40 m. One of the main characteristics of monocots is the lack of a distinctive and useful layer of productive cells known as vascular cambium, which in dicots appears between the xylem (that transfers water) and the phloem (that transfers carbohydrates). It also makes new phloem towards the inside of the stem, while the xylem is opposite to it.

As in palms there is no vascular cambium, water and carbohydrate conducting tissues become dispersed in whole internal stem. Woody dicots are able to expand their stem diameter and produce new vascular tissues, which is known as secondary growth. Horticulturists perform successful grafting and budding in closely related varieties and species of dicots due to the regenerative ability of cambium that also makes it able to fix injuries. On the other hand, palms lack cambium and therefore grafting and budding cannot be performed, as well as secondary growth. This means that once a palm tree reaches its maximum girth size it cannot raise stem size or diameter. Scattered xylem and phloem in palms stem last for the whole plant life. For this reason palms are also unable to fix their injuries. Most of the palms have only a single growing bud/node on the apical meristem. This apical meristem is hence vital for palms because it has only one single growing point. If it is damaged then the plant dies (Broschat et al. 2014).

Propagation of palms for commercial agricultural and ornamental objectives is achieved through seeds. However, there are certain species (*Phoenix dactylifera* and *Rhapis* spp.), which can be propagated through suckers (baby plants produced at the base of the mother plant) and tissue culture (Corley 1980). Seed propagation has certain serious problems such as the very low seed germination percentage and the long time needed for growth of seedlings. This is a challenge to produce uniform seedlings, with higher germination percentages.

Palm seeds usually take 90–120 days to germinate with only a 15–20% germination rate, which represent a great loss to producers. Palm seeds vary greatly in size, with the smallest seed measuring only 5 mm, while the biggest weighs up to 20 kg (this is the coco-de-mer Will Apse (Biologist from UK) palms *Lodoicea maldivica*). Germination in palms usually occurs in two ways: one is called remote germination, while the second is known as adjacent germination. In remote germination, a shoot from the cotyledon grows away from the seed, seedling shoot and radicle root develop, while the main cotyledon remains inside to provide food from endosperm in the form of nutrients. *Phoenix dactylifera*, *Livistona chinensis* and *Chamaerops humilis* are true examples of remote germination. On the other hand, if we see the adjacent procedure, a round button-like cotyledon grows, root develops from radicle and shoot emergence starts. *Syagrus romanzoffiana* and *Butia capitata* are best examples of this process.

Considering problems in palm seeds, the maturity of seeds stands on top. Most of the time seeds are immature, with an embryo that is not fully mature, causing a poor germination percentage. Also happens that all seeds are not synchronous, and

do not mature at a single time, originating a mixed germination frequency. There is an exception where maturity does not matter, as in *Dypsis lutescens*. The second major problem is the collection of fallen seeds. It is observed that fallen seeds always carry spores of disease causing agents, that do not let the seed to emerge. Thirdly, usually farmers treat seeds with higher concentrations of fungicides that cause low germination percentages and even a delay in the process. Suitable substrate selection is another problem in nursery raising, requiring good sanitation and disease-free growing media.

There are some easy tests to check the viability of seeds including float test, tetrazolium chloride test and the physical cut method. To perform float test, seeds must be placed in a container filled with water. Dead seeds will float while viable ones will soak. However, this method is old and scientists do not recommend it any more. In the tetrazolium chloride test, a selected population of seeds are cut in half and the embryos are coated with 1% or 10 g L⁻¹ of tetrazolium chloride (TTC), before being placed in the dark for 2–24 h. If the embryos become pink or red, they are viable otherwise they can be considered as non-viable. In the third test, the seeds are cut in half and the embryo and endosperm are observed. If the embryo is firm and colored and the endosperm fills all of its space in the seed coat, the seed may be considered as viable. If the embryo is discolored and the endosperm is dis-shaped, it is non-viable.

After seed selection, pre sowing treatments of palm seeds should be finalized. Growers and nurserymen commonly use scarification, stratification, soaking in water, removal of fruit remnants and application of chemical boosters such as gibberellic acid (GA) as pre sowing, or priming techniques (Nagao et al. 1980; Broschat and Donselman 1987).

Scarification-mechanical treatments to seeds are highly risky and require an experienced skill. Hard seed coat is a common problem in almost all palm species, and scarification is recommended for the hardest ones. In *Hyphaene* spp., only the upper husk, that is of a leathery type, should be removed mechanically. Mechanical treatments are harmful for the embryo, because a minute damage to the embryo turns the seed into waste. However, hammer hit, cutting of upper side to allow water access to endosperm, and levigation with stones are used which are being helpful to improve germination (Nagao et al. 1980).

Stratification-storage of seeds at a specific low temperature may help to break their dormancy. However, in case of palms, dormancy is usually not a problem. The main problem is instead with the hard seed coats, and suitable temperature during the germination period. It is recommended not to store palm seeds for years. If storage is necessary, then first remove fleshy fruits from seeds and wash with water to ensure the total removal of fruit residues. Secondly dry them, at temperatures higher than 15 °C, avoiding storage for more than 6 months (Broschat and Donselman 1987).

Soaking in water for a few days gives better germination rates. But if seeds are soaked in water and heated from below, the germination rates will be much higher. This procedure is even more effective than the use of chemical boosters/enhancers. Gibberellic acid, sulphuric acid and other chemical enhancers show good results, while hot water treatment showed the best results (Broschat and Donselman 1987).

Removal of flesh/fibrous fruit residue from the seed is necessary to boost up the germination rate. This procedure enhances the germination speed while the final germination percentage remains the same for both practices. However, fruits should be removed immediately because they may contain spores of different pathogens (Marcus and Banks 1999).

1.5 Pruning of Palms

Pruning is a judicious removal of plant parts performed to get specific objectives and goals, based on clear objective for each cut. In Pakistan, pruning is often limited to just cutting off branches, while this operation should be a totally scientific, experienced and skill-required job. Generally, it is thought that palms are slow growing plants and they do not require any pruning. Although they are slow growing, they need pruning to remain attractive and avoid diseases. As pruning requires certain goals, there are some objectives to achieve for members of this family. Palms are pruned to remove old dried fronds, collect fruits and remove suckers to maintain a solitary, main trunk. Old dried fronds are not a burden on plants, but when their cluster get wet by rain, they produce a conducive environment for fungal diseases (Pfalzgraf 2000). Insects are also observed in the skirt (old dried fronds that remain attached) of *Washingtonia robusta* that are lethal to the palm. It is also observed that when palms are planted on green belts, their old dried fronds often fall on vehicles that cause a severe damage. Approximately, all palm species produce fruits but few of them are edible, with a very little amount of commercial importance.

Date and coconut palms are two important commercial species in the world, and throughout history. Their fruits contribute a big cash value in the Horticulture sector of world trade. When we use these palms in landscapes, fallen dates produce a debris that cause hazards and may incubate insects as well as spores of pathogens. On the other hand, coconut palms produce a drupe of almost 2–3 lbs in weight that may cause serious injury to people. Fruit pruning of these palms is then also a necessary practice. Palms often produce basal suckers on their main trunk that affect the palm's look as well as snatching its single straight stem look. These suckers develop initially on the root system of palm, to later produce their own. Furthermore, these suckers are removed to maintain solitary straight trunk and to propagate more palms (Robinson 2004).

There are some important do's and do not's of pruning palms:

- Do not injure the living part of main trunk while pruning its frond or removing the sucker. This is advised because this damage cannot be healed up.
- Do avoid to damage the root ball of palm while pruning basal suckers because most of the nutrients available to palms are from upper surface of soil.
- Do not allow the flowers as well as fruits to develop because they use energy, cause mineral deficiency and create a messy debris when falling around the tree.

- Do pruning in the correct season, preferably in spring or summer months because it will differentiate growing and stagnant growth branches.
- Do not let the brown or paled leaves remain attached to trees because they cause certain mineral deficiency and induce this deficiency to newly growing leaves.
- Do pruning on newly growing parts, only if necessary, i.e. if planted indoor and/or space becomes limited.
- Do not over prune the palms. You must keep a desired and suitable shape that creates an attention in landscapes.
- Do pruning of 3 to 4 year older fronds. Palm's fronds may take 3–5 years to become mature, if you observe the new growth of current year, you must leave the last two growth of fronds and prune older than these. This helps palm to remain attractive until new growth becomes mature and protects new growth from heavy winds.
- Do pruning close to the main trunk but take care of living green part.

1.6 Common Ornamental Palms

1.6.1 *Areca Palm (Areca catechu)*

Origin This palm is also known as Areca palm, betel palm, or Indian nut. It is indigenous to Philippines. However, it now expanded over Asia and some islands of the Pacific Ocean and West Indies.

Growth and Botany *Areca catechu* is a small to medium sized species that grows almost up to 6–7 m height. Main trunk expands only 5-10 cm in diameter and leaves are medium green and assembled leaflets are attached. Areca palm also produce flowers which make a small, round fruit.

Propagation Seeds are the main source to propagate these palms, while suckers are also used for propagation. Seeds are sown in spring and seedlings are ready for transplant within 6–8 months. A low germination rate is a common problem of almost all species of palms especially in the case of Areca palms with rates lower than 25%, even after 100 days of sowing. Seed priming with bio-membrane and solvents is the best solution.

Economic Importance Suitable for symmetric gardening and for open indoor areas, i.e. super stores, malls and hotels. Fresh fruit is also used for some addictive beverages while its fruit is famous in Chinese people for chewing. Its fronds and trunks are used in local construction, in the making of weapons, and as sources of wax. *Areca* seeds are also widely used in traditional Chinese medicine as an anti-parasitic agent and antihypertensive agent. Its leaves and nuts are also used to cure

diarrhea, throat inflammations, dropsy, sunstroke, beriberi, edema, bronchial catarrh, and urinary disorders (Badet 2011).

Future Prospects Areca palms contain polyphenols, fibre, fat polysaccharides, protein, and alkaloids. Moreover, their content may reach 8–12% in fats, which may be used in preparation of confectionery. There are bright prospects of using Areca palm fruits in pharmaceutical industry, as a digestive and carminative anti-diabetic, against certain skin diseases, relieving asthma and low blood pressure. Its husk may also be used for preparing paperboards, hard boards, cushions and non-woven fabrics besides being a good source of furfural. Its leaf sheath has the potential to be used for preparation of single use cups, plates, plyboards, tea chest, packing cases and suitcases, which can be commercially exploited.

1.6.2 Toddy Palm (*Borassus flabellifer*)

Origin Toddy palm, also known with the common name Palmyra palm, is used to make wine, from flower sap sugar and other local products. Areng (*Arenga pinnata*), nipa palm (*Nypa fruticans*) and coconut (*Cocos nucifera*) are other palm species known as toddy palms. *Borassus flabellifer* originated from subcontinent India and Pakistan and other Asian countries.

Growth and Botany Grey trunk, rounded signs of leaf scars and a straight upright single stem growth increase its beauty, as it attains more than 30 m height. Leaves look like fans, with reasonable difference in two leaves. They remain attached to the trunk for several years. Growth in earlier stages is very slow, while in later stages it grows rapidly. Toddy is a dioecious palm in which male flowers are very short (only 1 cm long) while female floescence is long and round like a golf ball. After pollination these flowers produce edible fruits.

Propagation Off shoots and seed are the right way of propagation. Seeds are present in jelly type sockets of fruit. They have a slow growth and low germination rates, while offshoots grow smoothly with high survival rate. Seeds are sown in garden soil and become able to transplant after 5–6 month. First year of plant from germination to forward should be under semi shade, later growth needs sunlight for further metabolism.

Economic Importance Toddy palm is one of the best choice among flowering shrubs, lawn sides and other formal and informal landscapes. Older leaves of toddy remain attached to the palm for long time, where the dry and green leaves combination gives a different look in garden. In ancient times its fruit were stored unripen and roasted later. The fruit was used in the past as raw, cooked or pickled, with a taste like the coconut, so that it was usually offered to guests. The soft juicy part of the fruit (toddy) is used to make sweet dishes.

Future Prospects Toddy palm has several medicinal uses and may be used commercially in the pharmaceutical industry. Moreover, its leaves have potential to be used as thatching for house floor and walls, weaving into baskets, mats and many other items. A number of fibers can also be obtained which can be used for making hats, boxes, baskets, fans, etc.

1.6.3 Coconut Palm (*Cocos nucifera*)

Origin Most common known nut but actually it is a drupe fruit. The word coconut was derived from “coco” (Spanish and Portuguese) which means “skull” or “head”. *Cocos nucifera* is native to America. Old Sri Lankan, Indian and Malayan civilizations have great evidence of this palm in their history and religions. Its fruit, water, juices, milk, husk, oil, and coir are the main products being used for centuries.

Growth and Botany Coconut palm is one of the long and heighted palm trees. They are mainly of two types: dwarf and tall. Leaves are long up to 6 m. They do not leave any scar on stem when become old and fall. Fruit is mainly a round drupe almost 18–20 cm inches in diameter. The fruit contains a medicinally and economically important juice when harvested. Coconut palms need warm, humid areas to produce an economical crop, otherwise they have an ornamental use. Peak produce from a coconut palm tree is 70–80 fruits per year, from plants that need 10–12 years to reach this stage.

Propagation Coconut palms are conventionally propagated through seed. Recent research has shown that a coconut itself when having husk on it can be used to propagate further. Moreover, in recent days keeping in view the importance and demand of coconut trees they are being tissue cultured. Edible seeds or coconut with husk and water are placed in well drained media that finally raise seedlings. Seedlings need warm humid environment for better growth.

Economic Importance Coconut is used as food and oil as well as for ornamental purposes, in suitable coastal and warm humid areas. Landscapes in coastal areas are incomplete without coconut palms. It produces fruit and a list of by products which are important for their economic and medicinal value. Fruit itself is one of most demanded drupe in the world. Water in fruit has great medicinal value for stomach and renal care. Husk on fruit has a distinctive role in handicraft industry while hairy coir on husk is a very nutritive substrate for nursery production (Rajan and Abraham 2007).

Future Prospects As a cash crop, major components of coco palm include crude coconut oil (CNO) and copra (dried coconut kernel) (Mittaine and Mielke 2012). As a food crop, it is a source of coconut milk, sugar, coconut water, fibers, fuels, raw or virgin oil for cooking and cosmetics, while some varieties are also used in popular

medicines (Batugal et al. 1998). However, with value addition, new non-traditional products have entered into global markets, which include but not limited to virgin coconut oil (VCO), cold pressed from the fresh kernel, coconut water extracted from mature or immature nuts, or coconut sugar, taken from the sap flowing out of the flower, which have great prospects for future developments in the coco industry (Prades et al. 2016).



***Areca catechu* (Areca palm)**



***Borassus flabellifer* (Toddy palm)**



***Cocos nucifera* (Coconut palm)**



***Cycas revoluta* (Sago palm)**

1.6.4 *Sago Palm (Cycas revoluta)*

Origin This palm is also known as Japanese sago, king sago, kanghi and cycad palm. The species belongs to the Cycadaceae family, therefore it is considered as false palm, but its growth resembles to the palms, originated from Ryukyu Island of Japan. There are several species that are known as sago. Cycads are also drought tolerant. They shed their leaves in winter in temperate areas.

Growth and Botany Very symmetrical, straight and deep dark brown trunk of palm makes graceful old look. Trunk, when reaching 45–50 cm in diameter does not expand more in later ages. Height may reach up to 5 m, after 15–20 years of growth. Leaves are deep to semi dark green in color, emerge from main trunk and remain attached to plants for 3 years after emergence. Leaf petiole is covered with thorns and leaflets have very sharp head, that may punch a human hand while caring them. Cycads are dioecious, where male inflorescence have cones and female produces mega sporophylls. Insects, wind and men are carrier of pollens. Small orange round non-edible fruits are formed, that contain seeds.

Propagation Cycads produce suckers in their base, a most suitable, fast and easy way to propagate them as compared to seeds. Although, seeds are also being used in commercial propagation. Seeds need special priming strategies before sowing. Soaking in distilled water for a week before sowing lifts germination rates from 30% to 80%. Seedlings become ready for transplant within 120–150 days after sowing.

Economic Importance Formal landscapes always contain cycads as accent plant. Corner plantation and indoor gardening has cycads as prime plant. Horticulturists must know before planting that cycads may shed their leaves in temperate winter and a permanent indoor conditions. They need bright light in indoor conditions. Their leaves are **highly toxic** to pets and children. High amount of alkaloids extracted from their leaves are used in pharmaceutical industry. In some cultures, cycas leaves are used after cooking and their seed kernels are used in cakes.

Future Prospects Cycas has a potential as food and in medicine, and also as oil, fiber, and gum source. However, all plant parts are toxic. Cycas is one of most demanding cut foliage crop being used worldwide for its decorative leaves, which further has scope to expand its market demand. Some cycads also help in nitrogen fixing, which may be used for improving soil health and lowering fertilizers requirements for crop production. Metroxylon sago is real sago palm from family Arecaceae which is used to make sago daana, used to cure several digestive system ailments.

1.6.5 *Fish Tail Palm (Caryota mitis)*

Origin *Caryota* is a genus of almost 13 species of palm trees. They are commonly popular as fish tail palm just because of their leaves look like the tail of a fish. All are originated from India, China and Indonesian forests from where they spread to Florida and the Americas. *Caryota furfurea*, *Caryota griffithii*, *Caryota urens* and *Caryota javanica* are the most famous species in this genus. *Caryota mitis* grows well in hilly areas. On the other hand, adaptation to subtropical areas is very good than to tropical one.

Growth and Botany *Caryota mitis* has a cluster type habit created by multiple stems. Bipinnate leaves are long up to 1–2 m, while leaflets, less than a 30 cm, end in a shape reminiscent of a fish tail. Main trunk does not exceed than 15 cm in diameter while in height may reach up to 15 m. The purple flowers of *Caryota* grow below the leaves and produce a dark red to purplish, non-edible fruit.

Propagation By seeds, which show first germination after 90–120 days. Seedlings become ready after 60 days from germination. They need a 25–30 °C temperature with 60–70% humidity to grow quick. A bright light is good for initial years while full sun in tropical areas is sufficient to dry the leaves.

Economic Importance It is suitable for sub-tropical and tropical climates and will do well in containers or indoors. It is also used as accent plant in parks, is a very nice choice in group plantations and performs well in semi shaded areas. Its purple inflorescence is graceful while fruits are non-edible. However, it is rich in carbohydrates and proteins. Inflorescence is tapped for toddy and the pith of the trunk is extracted for a kind of sago flour (Burkill 1993; Whitmore 1998). The fruit wall and sap contains irritant, needle-like crystals.

Future Prospects Being rich in carbohydrates and proteins, it might be used as replacement of vegetable oil. Moreover, it has great demand in modern landscapes for its unique plant structure and is popular in Indo-Pakistan and other Asian countries.

1.6.6 *Chinese Fan Palm (Livistonia chinensis)*

Origin Chinese Fan Palm is one of the purely subtropical species of palm trees. It is also known as fountain palm. It originated to China and Japanese islands. Furthermore, they are now naturalized in Indo-Pakistan region, America, Middle East, Bermuda and Dominican Republic.

Growth and Botany Trunk has light wooden colored, non-even but clean surface and does not cross 30 cm in diameter while in height it reaches up to 8 m. Fresh and lush green leaves look like Chinese traditional hand fan, and may lengthen up to

1 m. The petioles have spines and leaves are half straight and half hanging. Fruits are blue in color while equals to size of an olive. It grows best in loam to sandy loam soil, with moist conditions and frequent irrigation.

Propagation *Livistonia* palm produces many seeds every year that is the only way to raise new plants. Seeds are placed in vermiculite or garden soil mixed with coco coir to get best germination percentage. Seedlings become ready for transplanting after 6 months of sowing.

Economic Importance It's the best choice for open space landscapes in subtropical and tropical areas. As accent plant in flowering shrubs it gives an informal attractive look. Aesthetic beauty is also expressed when placed in group of three or five palms. Accent plant in formal parks and lawns is another best placement of Chinese Fan Palm. It is generally planted in parks, parking lots, and on avenues. Moreover, its leaves are used for making fans, brooms, hats and raincoats in some Asian countries (Dowe 2009; Flora of China Editorial Committee 2016).

Future Prospects Along with its use as ornamental palm, it has also medicinal value in preparation of some medicines supposedly to cure diseases. Therefore, it has great potential to be used in pharmaceutical and landscape industries. *Livistonia chinensis* is being used as a medicinal herb in eastern Asia to treat certain types of tumors, which is a folk remedy to kill cancerous cells (Cheueng and Tai 2005).

1.6.7 *Bottle Palm (Mascarena revaughanii)*

Origin A species of flowering plant, its habitat is Mauritius island. One of the accent plant naturalized in many subtropical and tropical zones of world. They are cold sensitive and shed their leaves below 0 °C. The plant is also known as *Hyphorbe lagenicaulis*. Their commercial propagation is done in Asian countries like China, India, Pakistan, and USA.

Growth and Botany Bottle palm's trunk has a swollen base and height does not exceed than 2 m. The exact diameter of the trunk cannot be described because of the tapering habit from base towards head. It has maximum six and minimum four open leaves at a time. The pinnate, dark green colored, up to 1.5 m long leaves half roll around the trunk and make an aesthetically important canopy. Fruits are almost 2.5 cm long and orange to black in color. They contain a seed that is important for commercial propagation. Excessive heat from sunlight is crucial during first 3 years of growth. Well drained soil and frequent irrigation is the best recommendation for warm subtropical and tropical areas.

Propagation *Mascarena revaughanii* are propagated through seed. They do not produce suckers or offshoots. Seeds are sown in garden soil and seedlings become ready for transplanting after 150–180 days of sowing. The plants are ready for land-

scape purposes within 2 years. To enhance seed viability, a hydro priming technique and soak is applied to the costly seeds in water, for 5–7 days before sowing.

Economic Importance It is a highly expensive palm species, used for uniform design. It is well suited for the roadside plantation, which creates an avenue. Most of the time it is recommended for the tall buildings and artificial beach plantations. Fruit is non-edible but important for seed collection, while leaves are **toxic** to pets and children.

Future Prospects It is actually considered as one endangered palm species, which needs to be conserved in different parts of the world to safeguard its biodiversity.

1.6.8 *Canary Palm (Phoenix canariensis)*

Origin It is native to Canary Islands. It belongs to the same genus *Phoenix* that also include date palm, and shows more resemblance to the date plant when matures. It became an invasive palm species in many areas of world i.e. Bermuda, Florida, Hawaii, Australia, China, Japan and Indo-Pakistan region.

Growth and Botany *Phoenix canariensis* grows 15–20 m tall and has a straight single stem. Leaves are dark green and pinnate. They also contain spines on petiole while half roll along the tree canopy. They attain life for almost a century. They also produce purple bluish edible but tasteless fruits. A single seed is present in each fruit that is of prime importance in propagation. Well drained sandy loam soil with frequent irrigation is the best condition during early 5–6 years, while in later stages irrigation is applied only on demand. This palm is also slightly resistant to drought and salinity.

Propagation Canary palm produces a huge number of fruits every year, which contain seeds. Their propagation practice is done by seed as well as suckers. Canary palm produces its first sucker at the 8th year of life. Suckers are an easy way to propagate it and have high survival rates after transplant, but their removal from mother plant is a hectic and technical process. Seed priming with water is the best way to get high germination rates, otherwise sowing in hundred percent moist well drained media for 3 days also dissolve its hard endocarp. Seed takes 120–140 days to prepare seedlings for transplant.

Economic Importance It is the best choice for wide green belts of curly roads. Their plantation in group with base covered by annuals creates a look which shows bloom in autumn. Plantation in desert places does not affect their survival. Dried leaf petioles remain attached to main trunk, that makes a non-uniform but beautiful dry look.

Future Prospects Other than landscape and ornamental uses, pollens of *P. canariensis* are rich source of carbohydrates, proteins, amino acids, enzymes, fatty acids and minerals. Moreover, they are rich in steroids and saponins, with a potential in pharmaceutical industry to treat different types of tumors (Hifnawy et al. 2016). The pollen of *P. canariensis* is also beneficial and has prophylactic effect against prostatic hyperplasia (Hifnawy et al. 2018).



Caryota mitis (Fish tail palm)



Livistonia chinensis (Chinese Fan palm)



Mascarena revaughanii (Bottle palm)



Phoenix canariensis (Canary palm)

1.6.9 Date Palm (*Phoenix dactylifera*)

Origin *Phoenix dactylifera* is also a flowering palm species cultivated for dates. This species is naturalized over the world and acclimatized in a wide range of temperature zones, due to which there is a controversial discussion about its actual native area. However, signs of its origin are found in Mesopotamia (Middle East) and Arab peninsula. There is a strong evidence of cultivation of date for centuries, due to its edible, sweet fruit of highly commercial importance. There are more than 3000 varieties of date palms in various zones of world, although a selected list of almost 20 varieties is of commercial importance. Dates contain high amount of sugars when dried, being an historical staple food for thousand years in Middle East countries.

Growth and Botany Date palms have a single solitary stem with the bases of the leaf petioles attached to them. Moreover, it may happen sometimes that more than one stems grow on the same root system. *Phoenix dactylifera* generally reaches around 20–25 m in height. The stem is light brown to brown in color and produces suckers on its own root system. The roots also grow upright with the stem, and can be seen when suckers get removed. Leaves are light green on lower side and green on upper side. They contain spines attached to the petiole, with sides as sharp as a blade. It is dioecious (male and female plants are different) in nature and may be pollinated manually for commercial production. Male plants have small and wider inflorescences, while female plants have taller and thinner inflorescence. Male plants have more spines on petiole while female plants have a few. They are known for their strong resistance to drought and salt, in nature. Date palms produce almost 3–6.5 cm long oval edible fruit (size depends upon varieties), that contains one seed.

Propagation Dates are commercially propagated by suckers, produced by the plant itself. Although for ornamental purposes they are grown by seed. Undoubtedly, they have a low germination rate, but well drained aerated and nutritive soil media help the seed to grow well. Seedlings become ready after 8 months of sowing. These can also be propagated through tissue culture for mass propagation of disease free plants.

Economic Importance Excellent choice for landscape of desert areas whose irrigation depends upon only on rain water. Back plantation in parks, home and offices gives an aimed look. Fruits are of high commercial importance. Nowadays, bark is also being used as soil substrate of nursery production. People in developing countries made mats of dried date leaves. Dates are used for both dietary purposes as well as for phytomedicinal impacts against different diseases. Being a rich source of various phytochemicals with a strong antioxidant potential, they have great impact

on human health. Dates are rich in carbohydrates, proteins, alkaloids, fatty acids (palmitic, linoleic, lauric and stearic), vitamins, polyphenolic compounds, carotenoids, flavonoids, and tannins along with nutrients such as potassium, magnesium, calcium, and phosphorus.

Future Prospects Date palm is a unique food, industrial and pharmaceutical product. Being one of the oldest palm tree, which has environmental, nutritional, ornamental and economic significance, it has huge potential to be used as ornamental tree as well as in preparation of various folk medicines. Its oil has potential to be used in cosmetic and pharmaceutical industries. Different parts of date fruit can be used in preparation of various food supplements and medicines. Moreover, it has anti-inflammatory, antimicrobial, gastro protective and immunostimulant properties (Qadir et al. 2019).

1.6.10 *Royal Palm (Roystonea regia)*

Origin Royal palm is also known as Cuban or Florida royal palm. This species of palms was originated from Florida, Mexico and Caribbean areas, and has now naturalized in subtropics and tropics all over the world, as formal landscape tree. Royal palms were also mentioned in official landscape of Great British rule in eighteenth and nineteenth centuries.

Growth and Botany Its straight, long and grey trunk has most aesthetic value. Trunk achieves about 15–20 m height, when the tree gets mature. Fronds are 2 m long while in structure they are pinnate. Bright green colored leaves make a graceful crown-like canopy which is of utmost aesthetic importance. This palm grows well in tropical zone, while in soils sandy loam is best. They are also drought resistant. *Roystonea regia* produces unisexual inflorescences, where pollination carriers are bees and bats. Bats also eat its fruit and disperse seed.

Propagation Royal palms are propagated through seeds. Seeds initially produce only a part of the embryo, and the seedlings start to produce the stem 2 years after germination. It is reported that the royal palm grows 51 cm every year, after a specific period of time.

Economic Importance Being an excellent plant for formal landscaping, it is often recommended with flowering shrubs. High roof formal buildings and lawns of villas must have a Royal Palm as accent plant. Fruits are eaten by bats and they disperse seed all around. Seeds are used to extract oil and mix in livestock feeds. It is used as

stem beauty in landscapes. Its wood is also used for construction, while leaves for thatching.

Future Prospects Royal palm has great potential to be used in livestock feed preparation. Moreover, it has potential to be used in pharmaceutical industry to treat prostatic hyperplasia (Oyarzábal et al. 2017).

1.6.11 *Ravenala Palm (Ravenala madagascariensis)*

Origin *Ravenala madagascariensis* is a flowering plant, generally known as traveler's palm, which is a false palm, but its growth resembles to palms. It is native to Madagascar and belongs to the family Sterlitziaceae (Order: Zingiberales), a flowering monocotyledonous family. It is thought that sheaths of tree store rain water which later became useful in the past for travelers during journey, that's why it is known as travelers' palm. However, the water stored in sheaths of the palm is black and smelly, and should not be used before purification.

Growth and Botany Long petioles with paddle-shaped, banana-like leaves make a big fan, clearly visible in the landscape. Flowers are white in color and reminiscent of the bird of paradise plant (*Strelitzia reginae*), but considered less attractive. Lemurs and birds do pollination in ravenalas, resulting in the production of beautiful blue colored seeds. As the plant gets older, it sheds leaves and a dirty grey trunk appears with leaf scars. Generally, in landscape it reaches up to 7 m in height while in forests of Madagascar it attains about 20–30 m.

Propagation *Ravenala madagascariensis* produces seeds as well as suckers in the base. Both ways are suitable for commercial propagation, while offshoots are a quick way than seed. Seeds are placed in well drained nutritive soil media for 90–100 days for germination. After this period, the seedlings become ready to transplant 70–90 days after germination. Ravenalas need sunlight and humid conditions to grow smooth.

Economic Importance It is super accent choice for landscape and always a best recommended plant in parks and formal and informal landscapes. Its leaves are used for roofing, petioles for walls and bark as floor (Rakotoarivelo et al. 2014).

Future Prospects It is quite common in Madagascar and used as building materials. Moreover, using *Ravenala* in house construction reduces the use of slow growing trees and contributes to the sustainable use of natural forest resources.

1.6.12 *Desert Fan Palm (Washingtonia filifera)*

Origin Desert fan palm is also known as California palm, California fan palm, endemic to USA (California) and Mexico. It is another palm flowering species and a true example of plants which grow well in almost all parts of world. Desert, subtropical, tropical and lower hilly areas all are suitable for *Washingtonia filifera*.

Growth and Botany The fan palm has a massive, strapping, columnar long trunk up to 20 m. Its canopy also occupies up to 6 m. Leathery, wax type leaves show a dense green color. Older leaves remain attached to plants for several years and display like a skirt. A large range of soils (sandy loam, loam, clay and silt) and climatic zones (subtropical, tropical and low hilly areas) are suitable for its growth. However, well drained sandy loam with tropical zone is the best option for this species. They live for one to two and half centuries, depending on favorable climate. They form edible but tasteless fruits. In the sixteenth century, these fruits were used during a famine period in Southern Paiute (now part of California) to feed people. Fruits are small and black in color like a black berry, and contains seed.

Propagation *Washingtonia filifera* are propagated through seeds, that are small but with a hard coat. Seeds need 70–90 days for germination when sown in well-drained soil. They become ready to transplant 6 months after sowing.

Economic Importance Prominent choice for boundaries of landscape parks and big lawns. Its super beauty lies in the stem skirt made by old dry leaves. Wide canopy and high surface area of leaves absorb pollution. It also has a different look during the fruiting season, when black small berry-type branches of fruits hang along the stem. It is also habitat for several bird species.

Future Prospects These palms may have economic value in urban landscapes in tropical regions and may be used for making huts on beaches and coastal areas.



***Phoenix dactylifera* (Date palm)**



***Roystonea regia* (Royal palm)**



***Ravenala madagascariensis*
(Ravenala palm)**



***Washingtonia filifera*
(Desert fan palm)**

1.6.13 Mexican Fan Palm (*Washingtonia robusta*)

Origin This palm tree species is also known as common ornamental palm or Mexican Washingtonia, and originated from USA (California, Florida, Texas, Hawaii), Europe (Spain, Italy) and Asia (Lebanon).

Growth and Botany Fast growing long heighted palm with non-straight grey trunk, it reaches up to 25–30 m in height. The leaves are almost 2 m long, where half-length is the petiole and next half is a fan like leaf. A long (about 10 m) inflorescence consists of large number of pinkish flowers. The black, spherical, drupe fruit formed is edible and contains a seed. It is also suitable in a wide range of soils (clay, loam, sandy loam, silt) and agro-climatic zones.

Propagation *Washingtonia robusta* is propagated through seeds, which are placed in humid, warm conditions. Germination takes place in 60–80 days after sowing, while seedlings are ready to transplant 6 months after sowing. The palm grows, after transplanting, more rapidly than other *Washingtonia* species.

Economic Importance This palm is one of best choice with flowering shrubs, when it is not much more taller as during its mature age. It is also used as indoor up to 3 years of age. Background and corner plantation is most recommended place for Mexican fan palm. Its leaves were used in making baskets, sandals and roofs, while the fiber is used for making cords.

Future Prospects *Washingtonia robusta* fruits have high fermentable sugars, which can be used for extraction of ethanol. Ethanol extraction is getting popularity nowadays for alternate fuel production and *W. robusta* may be used as alternate to food crops for extraction of ethanol (Mazmansi 2011). Studies are also being conducted to use its fruit as urban food.

1.6.14 Foxtail Palm (*Wodyetia bifurcata*)

Origin The genus *Wodyetia* contains only *W. bifurcata* as a single species. This is known as foxtail palm because of its leaf shape and length. It originated to Australia Cape Melville (an area in Australia popular for biodiversity).

Growth and Botany Its trunk is grey and dark brown, with rings left by leaf scars. It grows up to 10 m high. Leaves are fragmented from mid and wider about 30 cm on tip. Leaves are long about 2 m and half roll towards earth, this is why known as foxtail palm. It can tolerate a wide range of soils, with sandy loam as the best. It does not need frequent irrigation, while full sun is best for rapid growth. They are also placed in semi shade as house plants, but growth becomes very slow. When it

is placed in a pot in which its roots occupy all the soil, it grows very quickly. White flowers develop and form a 5 cm long orange oval fruit.

Propagation Fox tail palms are propagated through seed. Seeds are sown in garden soil and germinate in almost 2 months. It has been seen that when seeds were treated with sulphuric acid, their germination took place in 1 week. Seedlings become ready within 90–100 days after germination.

Economic Importance Foxtail is best choice for semi-shade, full sun and as house plant. Group plantation creates focal points in parks. Plantation in central green belts of roads and lawns of high rise buildings creates a formal, path developing and aimful look. Maintaining foxtail palm is quite easy, since its trunk is self-cleaned and does not require pruning. It is also great for the pool area, patios, or even a Zen garden oasis.

Future Prospects Foxtail palms often suffer for deficiency of Fe, which leads to interveinal chlorosis and leaf spot, which can be controlled by soil application of the Fe chelate EDDHA (Broschat and Elliott 2005). It has potential to be used in urban landscapes and sometimes its seeds are even expansive than other crops. Foxtail palm also accounts for huge economic value.

1.6.15 *Ponytail Palm (Beaucarnea recurvata)*

Origin *Beaucarnea recurvata*, (another renowned name is Elephant's foot palm) belongs to the Asparagaceae family and is a false palm, however its growth resembles to palms. It is endemic to different states of Texas, America. They live for several centuries, even in Texas there are registered pony tail palms about 350 years old. Its leaves are of drooping nature around terminal portion that looks like banded pony of a girl, due to which known as Ponytail palm. Its base on soil is very wider and looks like the foot of an elephant, the reason behind the word elephant's foot.

Growth and Botany *Beaucarnea recurvata* is a perennial evergreen palm which grows up to 4.5 m in height. The light grey, uneven, but uniform surface of the trunk gives an old look to the plant. The trunk is swollen at base, almost 3 times the terminal portion. Leaves are long up to 2–3 m, while not wider than 15 mm. The leaves are smooth and bright green in color. A bunch of flowers appears after the tenth year of growth. Full sun to partial shade, with 20 °C average temperature is best for their fast growth. It has been seen that ponytails again develop from side nuds even after crown death. Pink bloom of plants develop small round blackish seeds.

Propagation *Beaucarnea recurvata* is propagated through division. Spring is the best time to divide all *Beaucarneas*. Take a multistem plant, uproot from soil and remove all the media. Take a sharp knife to make their swollen stem separate, while segregate all the roots carefully, attached to each swollen stem base. Plant separately

each one and irrigate well. A 18–22 °C temperature with moist conditions is best for root establishment. Seeds are also used to propagate ponytails. They require special care and are sensitive to too low/too high temperatures. The average temperature is 20 °C for best germination and seedling growth. Seeds need 2–3 months for germination and seedlings may be ready up to 3 months after germination.

Economic Importance A multitask plant in landscape which is used outdoors as well as indoors. As a specimen plant surrounded with annuals in a pot it provides an awesome look. It grows outdoor 2–3 times taller than indoors.

Future Prospects *Beaucarnea* is a common indoor plant, which has potential to purify indoor air and fill indoor landscape with fresh air. Its main use is only as ornamental.

1.6.16 *Bismarckia Palm (Bismarckia nobilis)*

Origin *Bismarckia* is a large graceful tree, endemic to Madagascar Island. The name derived from the German statesman Otto von Bismarck.

Growth and Botany *Bismarckias* when mature get heighted around 15 m in open grassland of Madagascar. Expanded older leaf's petiole remain attached to the plant that shows a grey color look. Stem and leaves both have a light grey color and provide an entirely different look in landscape. Leaves are 2–3 m long where petioles are almost 1 m long. Leaves remain in tilt angle rather other horizontal. Petiole is about 5–7.5 cm in diameter as stem that ranges from 5 to 7.5 cm (depends upon growth stage). *Bismarckias* grow best in open land and are strong tolerants to high temperatures and drought when matured. In initial years, they need well drained soil and humid conditions. *Bismarckias* are grown under subtropical and tropical areas over the world. They are dioecious in nature, but inflorescences of male and female plants (small brown flowers) look the same. Fruits are ovoid, small brown drupes formed on female plants, each with a single seed.

Propagation *Bismarckia nobilis* is propagated by small brown seeds that have a hard endocarp, and need some priming before sowing. The hard *Bismarckia* seed coat does not allow the cotyledonary leaves to open, so a halo or hydro priming approach is the best way to break the seed coat. Seeds need a 18–22 °C temperature with moist conditions for best germination and frequent irrigation when seedlings become ready. Later stages are tolerant to heat, and drought.

Economic Importance A very good, decent choice for focal point in lawn, corners in landscape parks. Central planting in low heighted flowering shrubs makes *Bismarckias* more stunning. Its stems are used as planks or in partitioning walls, while leaves are used for making baskets and for roofing.

Future Prospects It is one of most widely used palm species in landscapes around the world. Therefore, its seed as well as nursery demand is rising all over the world for its grey foliage color, which contrasts well with green background. They are best tolerant to heat and drought stress.



***Washingtonia Robusta* (Mexican fan palm)**



***Wodyetia bifurcata* (Foxtail palm)**



***Beaucarnea recurvata* (Ponytail palm)**



***Bismarckia nobilis* (Bismarckia palm)**

1.6.17 *Cane Palm (Dypsis lutescens)*

Origin *Dypsis lutescens*, also known as *Chrysalidocarpus glaucescens*, has many common names in different areas i.e. Yellow Palm, Golden Cane Palm etc. It is native to Madagascar, Philippines and South India while it has been naturalized over all of subtropical and tropical areas of El Salvador, Florida, Dominican Republic and Cuba. This is also a flowering member of palmae (Arecaceae) family. Its leaves develop as an upward arch-like wings of a butterfly from multiple stems, that's why also known as butterfly palm.

Growth and Botany The yellowish stem has fallen leaf rings, and makes multiple stems in an upright growth. Stem grows up to 36 m in open subtropical and tropical areas, while in indoor conditions it does not exceeds 18–24 m. Every stem has terminal leaves which are structurally pinnate, lengthen up to 2–3 m with several pairs of leaflets. Average temperature for a cane palm is 16–24 °C. It is also sensitive to high humidity levels. Sudden fall in temperature may cause the leaves to get dry. It bears a variety of soils, even high in clay, but does not bear over watering. There should be a dry period between two irrigations, especially when it is planted indoors. Cane palms produce orange-red flowers which form a small round seed.

Propagation *Dypsis lutescens* are propagated through seed, and division of co-lateral growing stems. Seeds are the main source of commercial propagation, while divisions are made on availability. Seeds are sown in spring and seedlings become ready in autumn. Irrigations must be applied carefully, because cane palms are very sensitive to moisture.

Economic Importance Cane palms are a fair choice for indoor plants because they provide a long time green tropical touch in indoor landscapes. They are also best choice in outdoor landscapes, with low height colorful shrubs. Their fruits are a suitable food for several birds.

Future Prospects As cane palm is the second best indoor palm after arecas, a rapid growth rate is expected in its future use with the growth of houseplants. Moreover, its use will increase due to its capacity to clean indoor air by filtering different pollutants such as benzene (coming from kitchen burnings), formaldehyde (coming from paints, furniture and cigarettes) and toluene (coming from building material and greases).



***Dypsis lutescens* (Cane palm)**

1.6.18 *Alexandra palm* (*Archontophoenix alexandrae*)

Origin

This member of Arecaceae family, endemic to northeast Australia also known as king alexandrae, king palm or palmier royal (French). Besides its origin, this species was first imported to Florida which later became one of the famous species in tropical, subtropical and lower northern spots of the globe.

Growth and Botany

Pure gray single trunk, 0.6–1.2 feet diameter with parallel rings drawn by leaf scars are key identification and beautification signs of Alexandrae palm. Compound pinnate leaves are evergreen with spiral arrangement and about 85 cm long leaf blade. Monoecious flowers bloom in summer which are light yellow in color with spike in arrangement. Flowers produce true, round, red berry in summer which is 1.6–3 cm

long. Mature tree makes 2–4 feet round canopy. King palm grows well in full and partial sun, acidic and neutral soil.

Propagation

Seeds are the main source to propagate these palms. Seeds are sown in spring and seedlings are ready to transplant within 6–8 months. Low germination percentage is common problem in almost all species of palms especially when seeds have hairy covering on hard seed coat. Seed priming with bio membrane solvents is the best solution.

Economic Importance

Suitable for symmetric gardening, line plantation along pathway of hotels and parks are landscape uses. It is also feasible in indoor plantation when younger in age. Besides landscape, this palm is also recommended for coastal rainforests to reduce water and wind approach towards peri-urban areas.

Future Prospects

A high value palm plant for formal landscapes and for erosion control in peri-urban settings.

1.6.19 Queen Palm (*Syagruss romanzoffiana*)

Origin

Syagruss romanzoffiana is one most ordinary and common palm tree of southern as well as northern parts of California, which is now distributed over the world. In early 1800s Louis Choris named it as *cocos romanzoffiana*. Later on Bee F. Gunn (Geneticist) described that queen palm is not member of *cocos* genus, he added this plant in *syagruss* genus of *Arecaceae* family.

Growth and Botany

One of medium sized palm tree ranges from 9–13 m but maximum record height is 15 m. Pinnate leaves with 300 – 500 leaflets. One bunch of leaves develop every year. Leaves remain healthy for 3 years and older leaves fall every year leaving their petioles. Long biscuit color inflorescence produces fruits containing seeds. It produces small, yellow and edible fruits. Fruits taste is mixture of banana and plum. Seeds have brown hard seed coat covered with husky material. They remain alive for a year if stored dry at 15–20 °C temperature. Seeds have long dormancy and only source of propagation in in-vivo conditions. Sandy to sandy loam soils with good aeration are suitable for these palms. Queen palms are tolerant to high pH and EC. Queen palm is one of the few palms which can tolerate low temperature up to –5 °C. They are native to tropical regions but now distributed in all tropical, sub-tropical and lower temperate regions of the world.

Propagation

S. romanzoffiana is propagated through seed. Moreover, due to hard seed coat seeds take 150–180 days to germinate but germination percentage is < 20%. Hydro-priming technique is used to enhance germination and shorten the germination time by soaking seeds in water for 4–7 days.

Economic Importance

Accent plant in landscapes. Leaves and inflorescence are used as fodder for animals in endemic areas of queen palm. Best choice in rapid growing palms. It attains almost 2 m height within 2 years of growth.

Future Prospects

Highly valuable palm for landscape uses as well as fodder for livestock.

1.6.20 *Ravenea Palm (Ravenea rivularis)*

Origin

R. rivularis, also known as majesty palm, is originated from island of Indian Ocean known as Madagascar. This is also a descent member of family Arecaceae. Previously, it was in most endangered palm species of the world but later introduction as houseplants spread this plant over the world. Major commercial cultivated area is south California.

Growth and Botany

Generally, this is a slow growing species but attains up to 20 m height with the time. Single trunk is tapered towards neck, ringed by leaf scars and 0.3–0.4 m in diameter. Fronds are 2–3 m long with pinnate arrangement having arch like twist at end and small bare petiole at base. Male and female flowers are borne on separate plants but looks same in white color. Female inflorescence is more erect and long as compared to male. Fruits are red in color and 1–1.25 cm long in size. High humid areas with fertile land are best for this species.

Propagation

Majesty palm produces a plenty of seeds every year that is the only way to raise new plants. Seeds are placed in vermiculite or garden soil mixed with coco coir to get best germination percentage. Seedlings become ready for transplanting after 6 months of sowing.

Economic Importance

The shape and specific arrangements of fronds makes it a specimen as well as accent plant. Now it is a popular indoor houseplant up to 10 years of life. It is a highly water and salt tolerant species. This is also non-poisonous to pets and children.

Future Prospects

Highly suitable plant for focal points in landscape and most suited indoor palm during early growth stages.

1.6.21 *Phoenix Palm (Phoenix robelenii)*

Origin

Phoenix palm also known as pygmy date palm due to its growth behavior similarity to date, belongs to Arecaceae family while endemic to south Asia as well as northern parts including China, Vietnam and sub-continent. Very well adapted to wide range of climates from tropical and sub-tropical to northern areas.

Growth and Botany

Solitary stem with stubble surface towards leaf flush, light brown from base while dark from end grows straight. This species attains up to 3 m height while 6–12 inch diameter. Leaves are shiny and green in color while up to 1 m long with slight arch at end of every leaf. It bears up to -3°C while in extremes up to 52°C . Inflorescence produces small light yellow flowers that develop in minute date just 1 cm long fruit. Propagation These palms are commercially propagated by suckers, produced by plants itself. Although are also grown by seed. Undoubtedly, they are less in germination percentage but well drained, aerated and nutritive soil media helps seed to grow well. Seedlings become ready after 6 months of sowing.

Economic Importance

Best choice in focal points when base is surrounded with low heighted shrubs and ground covers. Shiny green leaves with dark brown stem makes it more attractive for viewers. On the other hand, adaptation to extreme high and low temperatures, water logging and salinity makes it more feasible for growers. This is also being used as houseplants.

Future Prospects

Best choice to be used in landscape as containerized plant or for patios and corners with groundcovers around base of the palm.

1.6.22 *Mazari Palm/Peesh Palm (Nannorrhops ritchiana)*

Origin

Nannorrhops ritchiana is an especially eye-catching palm due to its blue – green leaves and is one of the hardiest palm in the world. It is native to Middle East to Pakistan (It is found in Punjab specially in hilly areas of Dera Ghazi Khan (Fort Munro hills and Koh-e-Suleman mountain ranges) and some places of Balochistan and KPK hilly areas). Its high altitude desert type origin in Iran, Afghanistan and Pakistan growing at altitudes up to 1600–1700 m gives an indication of its requirements. *Nannorrhops ritchiana* are successfully cultivated in such diverse places as California, Florida, Texas, France, Italy and Venezuela. It is successfully grown in pots and put it outside more than 10 years. In winters, its cold hardiness is -10°C and if possible its roots keep dry, it may resist temperatures as low as -4°C . During

summer heat it is comparatively fast growing and develop into a large shrub with many short erected trunks, thick blue – green and leathery fan shaped leaves.

Growth and Botany

Maari palm/Peesh palm has monotypic genus of palm. It is clumping, unarmed, fan shaped palm with subterranean trunk and reaches to 1–5 m height. Mazari Pal/Peesh Palm has slow growing habit and must have excellent drainage. Mazari/Peesh palm is dioecious with male and female flowers on separate plants. Its individual stem has monocarpic habit, dying back on the soil after flowering and the plants continue its growth from the basal sprouts. Flowering stalks are about 1 m with yellow flowers. Usually used as ornamental plant but due to its slow growth habit it is not widely cultivated all over the world.

Propagation

Mazari/Peesh Palm are propagated through fresh seed within 4 months and also propagated through clumps. Single plants are capable of producing fertile seed. Seed germination is very slow and fickle. Fruit colour of the palm is reddish brown and each fruit has a single seed.

Economic Importance

This palm is native to desert areas, so is best choice for landscape of desert areas, stony soils, rainfed areas and infertile places where irrigation depends on rain water. Due to its clumping and shrub like habit it is the best choice for outdoor landscaping in sunny areas of the subtropical and temperate regions with low height and foliage beauty of its bluish green leaves. People in developing countries specially in tribal areas of Pakistan where Mazari/Peesh palm naturally grows make prayer mat, sleeping mat, handmade shoe (Slippers), hotpot, storage of grains, hat, brooms, baskets, burden basket (for carrying loads on horses and donkeys mostly used in mountainous areas, Pot rope, Cordage, trays, bread pots, chair, hand fan, rosaries, face mask and thatch of dried Mazari Plam/Peesh Palm leaves (Ali et al. 2020).

Future Prospects

Nannorrhops ritchiana has great potential in handmade handicrafts and is an economically important plant to improve the low income families. Due to its charismatic and bluish evergreen crown, it is commonly planted for ornamental purposes in sub-tropical and dry regions. Fresh fruits are edible and are directly eaten as a purgative and a tonic. The leaves extract is used to treat diarrhoea and dysentery in traditional medicine (Ali et al. 2020).

1.6.23 Caranday Palm (*Copernicia alba*)

Origin

Copernicia alba is an attractive palm due to its phyllotaxy pattern on its stem. It belongs to south America and due to its stem beauty is successfully grown in tropical, subtropical and as well as in temperate regions.

Growth and Botany

An attractive palm with slender stem which reaches to height of 25 m tall and a rounded crown of stiff leaves and the inflorescence arises among the leaves and has bisexual flowers.

Propagation

Copernicia alba are propagated through seeds. Fresh seeds germinated promptly in 3–4 months. Seedling growth is slow and takes a lot of time to reach maturity.

Economic Importance

Copernicia palm is highly expensive palm species and is well suited for the road side plantation, which creates avenues.

Future Prospects

Copernicia palm has great demand in tropical and subtropical countries and is a high demanded palm in commercial nurseries for use in landscapes.



Alexandra palm (*Archontophoenix alexandrae*)



Queen palm (*Syagrus romanzoffiana*)



Ravenea Palm (*Ravenea rivularis*)



Phoenix palm (*Phoenix robelinii*)



Caranday Palm (*Copernicia alba*)



Mazari Palm/Peesh Palm (*Nannorrhops ritchiana*)

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